APPENDIX A — Documentation for Spreadsheet Tool to Estimate Pollutant Loads (STEPL)

GENERAL DATA AND SOFTWARE

The subwatersheds used were from an older 14-digit Hydrologic Unit Code file (HUC 14) obtained from the Illinois Environmental Protection Agency. GIS operations were carried out using ESRI ArcMap 9.2 /9.3 with the Spatial Analyst extension. STEPL version 4.0 beta was used. The 2001 National Land Cover Dataset was downloaded from the Multi-Resolution Land Characteristics Consortium website.[1] Soil Survey Geographic (SSURGO) Database information for McHenry County for use in soil erosion estimation was downloaded from the Natural Resources Conservation Service Soil Data Mart website.[2] Other data sources are referenced as necessary in the documentation below.

Model Documentation

INPUT TABLE 1: INPUT WATERSHED LAND USE AREA (AC) AND PRECIPITATION (IN)

The STEPL model allows five different land cover types: urban, cropland, pastureland, forest, and a user-defined type that in this project is mainly wetlands and open water ("wetlands/water/NEC," where "NEC" is "not elsewhere classified"). The wetlands/water/NEC category is assumed not to be a pollutant source. In our implementation of STEPL, the land cover types were based on the classifications from the 2001 National Land Cover Dataset and updated to reflect changes logged in the 2005 draft land use inventory for northeastern Illinois conducted by the Chicago Metropolitan Agency for Planning.[3] The 2005 land use data were also used to develop urban subclasses for STEPL Table 8.

Table A-1

STEPL	NLCD 2001 land cover	Acreage
Urban	Developed Open Space	2,892
	Developed Low Intensity	2,115
	Developed Med Intensity	283
	Developed High Intensity	103
Forest	Deciduous Forest	4,372
	Evergreen Forest	14
Cropland	Cultivated Crops	15,240
Pastureland	Pasture/Hay	6,100
Wetlands/water/NEC	Barren Land	51
	Grassland/Herbaceous	272
	Woody Wetlands	34
	Open water	154
	Emergent Herbaceous Wetlands	3
Total		31,633

The methodology was as follows. First, 2001 land cover data were reclassified into the STEPL categories, as shown in Table A-1, and converted from raster to shapefile. Land use polygons were then intersected

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[1] http://www.mrlc.gov/mrlc2k_nlcd.asp
[2] http://soildatamart.nrcs.usda.gov/
[3] Other land cover datasets are available, but the one chosen seems to best meet the needs of the project. While the National Agricultural Statistics Service's Cropland Data Layer is updated each year, it does not separate pastureland from non-agricultural uses and its representation of urban land is crude. The Illinois GAP land cover dataset is now almost ten years old and simply provides an additional but unnecessary level of detail on vegetation considering the simple land cover categories used in STEPL. This is the case a fortiori with the Chicago Wilderness land cover dataset for 1998-1999.

with the reclassified 2001 land cover shapefile and with the HUC 14 subwatershed shapefile. Land cover was then updated by comparing classifications in 2001 and 2005 and assigning a final classification. This led to the decision rules in Table A-2. Essentially, the polygon was assigned a land cover based on its 2005 land use unless the land cover associated with a given land use was indeterminate; in that case the 2001 land cover classification was used. If the 2001 land cover was urban but the 2005 land use was not, the polygon remained urban and was assigned an urban subclass based on the 2005 land use. Updating the land cover data as described yielded the values shown in Table A-3 for the Upper Kishwaukee river watershed with an approximately 2005 vintage. The main results of the operation described above were to increase the amount of land classified as urban and increase the amount considered pastureland, and add to the wetland/water category.

Table A-2

If the 2005 land use was…	Then the polygon was assigned a 2005 land cover of…	And assigned an urban subclass of…
Single, duplex, and townhouse units	Urban	Single family
Farmhouse	Urban	Single family
Multi-family	Urban	Multifamily
Retail Center	Urban	Commercial
Single-structure office	Urban	Commercial
Business park	Urban	Commercial
Cultural and entertainment	Urban	Commercial
Hotel/motel	Urban	Commercial
Medical and health care facilities	Urban	Institutional
Educational facilities	Urban	Institutional
Government administration and services	Urban	Institutional
Religious facilities	Urban	Institutional
cemetaries	Urban	Institutional
Other institutional	Urban	Institutional
Mineral extraction	Urban	Industrial
Manufacturing and processing	Urban	Industrial
warehousing / distribution center	Urban	Industrial
Industrial park	Urban	Industrial
Aircraft transportation	Urban	Transportation
Communication	Urban	Transportation
Utilities and waste facilities	Urban	Transportation
Row crops, grains, and grazing	Value of 2001 land cover	Urban – cultivated*
Nurseries,greenhouses, orchards, treefarms, and sod farms	Value of 2001 land cover	Urban - cultivated*
Other agricultural	Value of 2001 land cover	Urban - cultivated*
Horse farms[4]	Pastureland	Not urban
Open space, primarily recreational	Urban	Open Space
Golf courses	Urban	Open Space
Open space, primarily conservation	Value of 2001 land cover	Open Space*
hunting clubs, scout camps, and private campgrounds	Value of 2001 land cover	Open Space*
Vacant forest and grassland	Value of 2001 land cover	Open Space*
Wetlands > 2.5 acres	Wetlands/water/NEC	Not urban
Under construction, residential	Urban	Vacant - Developed
Under construction, non-residential	Urban	Vacant - Developed
Other vacant	Urban	Vacant - Developed

[4] The acreage of horse farms in the 2005 land use inventory seems high in comparison to the estimates provided by McHenry County SWCD in the next section. However, the land use inventory is almost certainly correct to label the polygons in question as pasture of some sort, which is sufficient for the generalized purpose here.

If the 2005 land use was…	Then the polygon was assigned a 2005 land cover of…	And assigned an urban subclass of…
Rivers, streams, canals	Wetlands/water/NEC	Not urban
Lakes, reservoirs, and lagoons	Wetlands/water/NEC	Not urban
Total		

* If coded as urban in 2001 land cover dataset

Because the watershed plan stakeholder group pointed out that the McHenry County stormwater ordinance would offer protection to wetlands during development and that these wetlands were identified through the county ADID study, we elected to overlay these wetlands on the updated 2005 land cover and allow them to override whatever classification was originally present in order to be sure that the present-day and horizon year scenarios used the same base data for the wetlands. Wetland polygons in the land use inventory were primarily drawn using the National Wetlands Inventory coverage and updated using aerial photography; so it appears that the National Land Cover Dataset does a poor job of identifying wetlands in some conditions, considering the large increase in the wetland/water/NEC category. Most of this change in fact does result from the wetland classification, and wetlands and water represent 92% of the category. Finally, Input Table 1 also allows users to specify the acreage of feedlots, but they are not thought to exist in the watershed.

Table A-3

Subwatersheds	Urban	Cropland	Pastureland	Forest	Wetland/water/NEC	Total
180	1,475	573	275	478	532	3,334
189	790	3,758	1,479	189	450	6,667
203	1,256	801	147	200	517	2,921
210	399	127	20	53	137	737
213	221	1,363	102	41	246	1,972
216	33	575	67	1	15	691
224	95	594	82	39	70	881
225	641	1,073	307	197	490	2,707
229	94	590	35	14	90	823
246	328	516	455	114	284	1,698
254	260	285	398	318	374	1,634
260	285	922	768	77	549	2,600
264	220	279	66	12	45	621
273	1,362	528	275	213	486	2,863
282	478	712	98	113	145	1,546
Updated Total (2005)	13018	2407	2800	5041	8367	31633

INPUT TABLE 2. INPUT AGRICULTURAL ANIMALS

Nutrient concentrations in STEPL are treated as a function of animal density in the watershed. This was abandoned in favor of directly entering the nutrient concentrations in Input Table 7.

INPUT TABLE 3: INPUT SEPTIC SYSTEM AND ILLEGAL DIRECT WASTEWATER DISCHARGE DATA

The McHenry County Health Department does not keep records of the location of septic systems. We therefore turned to the Census, which last collected information on the type of sewage disposal systems serving housing units in 1990. This was retrieved for the block groups overlying the watershed, as the block group is the smallest geography for which the Census long form sample data are valid. The block groups and HUC 14 subwatersheds were intersected in ArcMap, after which acreages were recalculated. The attribute table was then exported to Excel where sewage system data from the Census were appended. The number of septic systems in each subwatershed was estimated = the number of septic systems in block group ÷ area of block group × area of subwatershed intersecting the block group (Table A-4).

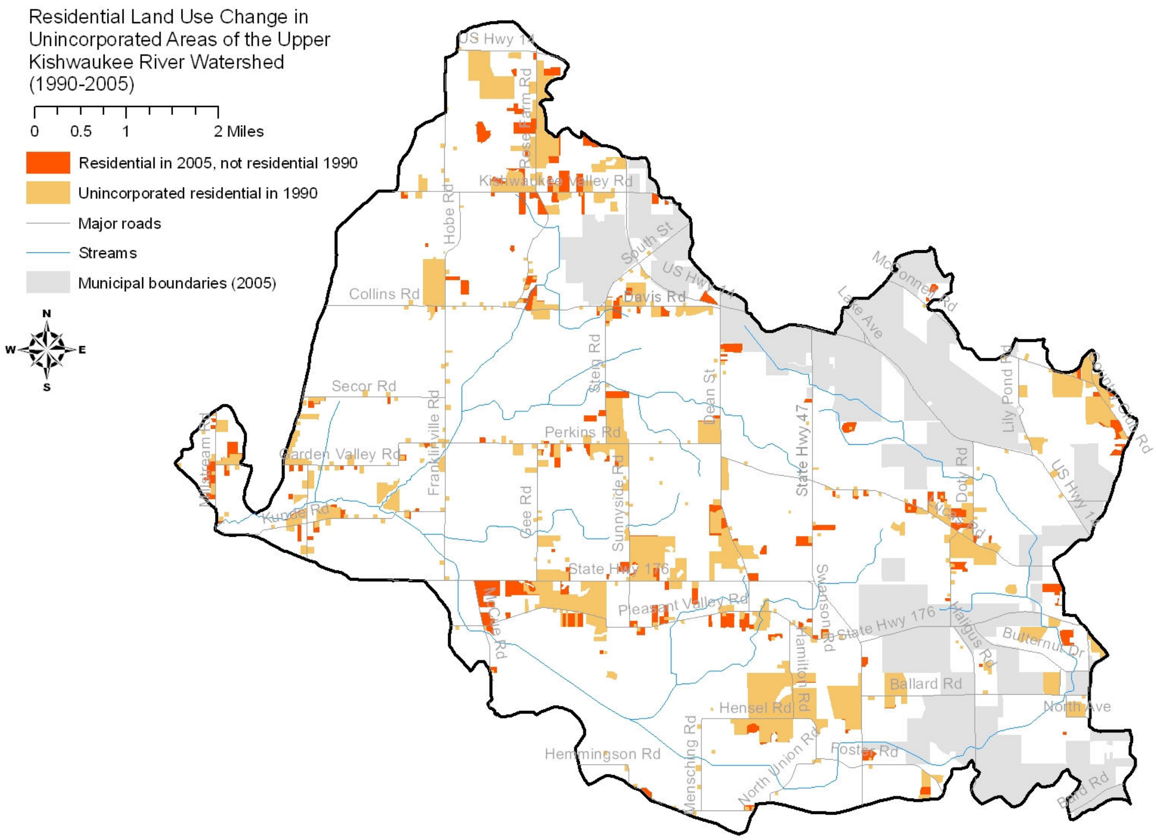
Table A-4

Subwatershed	Septic systems in 1990	Septic systems in 2005
180	46	65
189	84	102
203	46	86
210	9	48
213	25	29
216	8	9
224	11	13
225	65	82
229	10	11
246	23	39
254	19	25
260	28	36
264	8	14
273	167	196
282	11	12
Total	**559**	**767**

We then estimated how many new septic systems had been installed since 1990. To make the problem tractable, it was assumed that all new septic systems would be associated with residential land uses in unincorporated areas. First, the Northeastern Illinois Planning Commission's 1990 land use inventory was intersected in ArcMap with the (draft, unreleased) 2005 land use inventory. Polygons that were coded as residential in 2005 but not 1990 were then selected and exported. From this set, the polygons that lay wholly outside 2005 municipal boundaries in the watershed were selected and exported. Because of positioning inconsistencies between the 1990 and 2005 inventories, a number of small "sliver" polygons were left over from the intersect operation. The problem was partly corrected by deleting all polygons < 1 acre in area. This was the minimum qualifying acreage to be coded as an individual residential polygon outside the City of Chicago in the land use inventory, and so could not represent a valid polygon. It was assumed that any remaining slivers would have a negligible impact on the final calculations. The final set of polygons was considered to represent residential growth in unincorporated areas of the watershed between 1990 and 2005 (Figure A-1).

Land use polygons coded as residential in 1990 but still within unincorporated areas in 2005 were also intersected with the HUC 14 subwatersheds. Then, assuming that all septic systems from the 1990 Census were located within NIPC's 1990 unincorporated residential polygons, the number of septic systems installed up to 2005 could be estimated = the number of septic systems by subwatershed in 1990 ÷ acreage of unincorporated residential land use in 1990 × acres of residential growth in unincorporated areas from 1990 to 2005.

Figure A-1



Requirements for septic tank siting and installation in McHenry County were substantially strengthened in the 1990s so that, according to staff, septic tanks installed since then are unlikely to contribute to surface water quality degradation through overcharging.[5] The relatively young age of systems installed since the early 1990s also suggests failure would not be widespread. Therefore, the baseline analysis counts only septic systems in place in 1990 as likely to contribute to water quality problems. Population per septic system was assumed to equal average household size (2.91) in McHenry County in 2000 rather than the default value of 2.43. The default national failure rate of 2% could not be adjusted to local conditions for lack of better information. It was further assumed that there were no direct discharges of septic systems to streams.

INPUT TABLE 4: MODIFY THE UNIVERSAL SOIL LOSS EQUATION (USLE) PARAMETERS

The contribution of sediment from non-urban land (cropland, pastureland, and forest) is modeled using the Revised Universal Soil Loss Equation (RUSLE). This method uses the empirically derived equation $A = R \times K \times LS \times C \times P$, where A = average annual soil loss in tons per acre per year, R = rainfall/runoff erosivity, K = soil erodibility, LS = hillslope length and steepness, C = effect of cover management, and P = effect of support practices. Each of these factors can be adjusted to reflect local conditions. The STEPL model provides user defaults based on countywide averages. However, we sought to improve these defaults by making estimates applicable to each subwatershed. Furthermore, as STEPL Table 4 is

[5] Personal communication from Mike Eisele, McHenry County Health Department, December 13, 2007

organized as a matrix of subwatersheds and land cover types, unique factors were provided for each subwatershed and land cover combination where possible.

R factor

The R factor was assumed to be uniform throughout the watershed and equal to 180, the countywide average.

K factor

The K factors were estimated by joining the RUSLE attributes from the tabular SSURGO data to the SSURGO soil layer, then intersecting with the subwatershed and land cover type files. The mean K factors for the soils in the wetland/water/NEC category were estimated as unweighted means because of problems with zero (no data) values in a land cover category that occupies such a small part of the watershed. The countywide average K figure used as a default in STEPL is 0.23.

Table A-5

	Area-weighted mean K factors by subwatershed and land cover type			
Sheds	Forest	Cropland	Pastureland	Wetlands/water
180	0.30	0.27	0.26	0.20
189	0.29	0.26	0.27	0.23
203	0.26	0.27	0.26	0.29
210	0.19	0.24	0.31	0.22
213	0.27	0.28	0.27	0.21
216	0.19	0.27	0.29	—
224	0.30	0.27	0.29	0.19
225	0.30	0.28	0.26	0.23
229	0.27	0.26	0.29	0.22
246	0.30	0.29	0.29	0.22
254	0.33	0.31	0.29	0.26
260	0.28	0.24	0.18	0.22
264	0.32	0.27	0.29	0.27
273	0.24	0.29	0.27	0.24
282	0.31	0.22	0.32	0.30

LS factor

The LS factor was derived by a method that determines the contributing area to a point on a hillslope, in this case modeled as the number of "upstream" cells in a digital elevation model that flow into a given cell.[6] This value for each cell is called flow accumulation. Briefly, the steps were as follows:

1. Create a flow direction raster using the Flow Direction tool in Spatial Analyst with a 1:24,000 DEM from the USGS as the input. Using the Sink tool, the prevalence of cells that do not have outward flow was determined. As the sinks were very few in number (<< total number of cells), it was not deemed necessary to create a "depressionless DEM" before calculating flow accumulation.
2. Create a flow accumulation raster using the flow direction raster as the input.
3. Using the USGS 1:24,000 DEM and the Slope tool, create a slope raster with the output measurement set to degrees.

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[6] Described in Moore, I. and G. Burch. 1986a. *Physical basis of the length-slope factor in the universal soil loss equation.* Soil Science Society of America Journal 50:1294-1298. For the GIS implementation employed here, see B. Engel's methodology at http://cobweb.ecn.purdue.edu/~abe526/resources1/gisrusle/gisrusle.html.

4. Create the LS factor raster in Model Builder using the equation [LS] = {([FA] * ℓ / 22.13) ^ 0.4} * {sin ([S] * 3.14 / 180) / 0.0896} ^ 1.3, where [FA] is the flow accumulation raster, ℓ is the length of the raster cell side in meters (equal to 30 in this case), and [S] is the slope raster.
5. Tabulate mean LS factors by each unique combination of subwatershed and land cover type using the Zonal Statistics as Table tool in Spatial Analyst.

The results of this analysis are given in Table A-6. The countywide average LS figure used as a default in STEPL is 0.27.

Table A-6

	Mean LS factors by subwatershed and land cover type			
Sheds	Forest	Cropland	Pastureland	Wetlands/water
180	0.68	0.27	0.35	0.22
189	0.31	0.12	0.23	0.14
203	0.41	0.23	0.27	0.2
210	0.31	0.15	0.34	0.19
213	0.38	0.27	0.32	0.57
216	0.1	0.17	0.06	—
224	0.66	0.25	0.37	0.44
225	0.44	0.22	0.27	0.29
229	0.12	0.09	0.22	0.12
246	0.31	0.2	0.2	0.14
254	0.64	0.28	0.29	0.42
260	0.25	0.13	0.14	0.08
264	0.21	0.16	0.13	0.18
273	0.43	0.26	0.32	0.21
282	0.58	0.12	0.36	0.39

C factor

The cover management or C factor for cropland depends on tillage practices, crop rotation, and percent coverage. To develop a C factor representing each subwatershed, the problem was simplified to consider only corn, soybeans, and wheat, the three main crops grown in the watershed. Using Illinois Department of Agriculture transect survey values for McHenry County (2004), the proportion of the county in each tillage type × C factor was calculated for each crop rotation. These were summed for each crop rotation and then averaged, yielding 0.16 for corn, 0.08 for beans, and 0.01 for wheat. These representative values were then weighted by the area of the subwatershed planted in each type of crop in 2006,[7] yielding the subwatershed C factors shown in Table A-7.

The C factor for pastureland depends on the amount of total cover, which can be broken down into ground cover and canopy. Although it is obviously possible to estimate this at the plot level, there is no reliable way to estimate it at a subwatershed level. The default C factor value for pastureland is 0.04. This could be considered to represent 60% total cover with 40–50% ground cover with a low level of productivity.[8] The C factor for forest is likewise difficult to estimate, although the default value of 0.003 is more representative of evergreen forest than deciduous. The forest C factor was changed to 0.009 to represent the deciduous forest dominant in the watershed.

[7] Taken from National Agricultural Statistics Service's Cropland Data Layer (http://www.nass.usda.gov/research/Cropland/metadata/metadata_il06.htm)
[8] See NRCS Field Office Technical Guide at http://efotg.nrcs.usda.gov/references/public/IL/ArchivedRUSLE.pdf, p. 60

Table A-7

	Acreage of Crop			
Subwatershed	Corn	Soybeans	Winter Wheat	Subwatershed C-factor
180	256	184	134	0.10
189	2481	1431	139	0.13
203	336	642	33	0.10
210	18	108	6	0.09
213	592	408	28	0.12
216	297	224	1	0.13
224	386	167	12	0.13
225	539	476	53	0.12
229	212	320	37	0.11
246	102	301	62	0.09
254	59	130	53	0.08
260	468	729	96	0.10
264	40	67	18	0.10
273	186	164	113	0.10
282	233	364	40	0.10

P factor

Agents for the NRCS and the SWCDs in the Kishwaukee basin typically use a value of 1 for the supporting practices factor (P factor),[9] and the default in STEPL is 1 as well except in the case of cropland, which is 0.978. This was changed to 1 for lack of a credible means of generalizing the use of supporting practices to a subwatershed level.

INPUT TABLE 5: SELECT AVERAGE SOIL HYDROLOGIC GROUP (SHG), SHG A = HIGHEST INFILTRATION AND SHG D = LOWEST INFILTRATION

In ArcMap, the HUC 14 subwatersheds were intersected with the digital soil survey (SSURGO) for McHenry County. The Hydrologic Soil Group (HSG) with the largest acreage in a given subwatershed was chosen as the representative HSG for that subwatershed. As the column "Avg" in Table A-8 shows, the majority of the subwatersheds had primarily HSG B soils, although five were dominated by HSG C soils with lower infiltration potential.

STEPL Table 5 also provides an option to change the assumed soil concentration of nitrogen and phosphorus as well as the biological oxygen demand (BOD) load from soil. The spreadsheet references national soil maps in the file "SoilNP.xls" that indicate the watershed lies within an area with generally ≥0.2% soil nitrogen content. We assumed that nitrogen content was exactly 0.2%. The watershed lies within an area with generally 0.10 to 0.19% P_2O_5 content, so using the midpoint of the range, 0.15% × 0.44 = .066% of the soil is phosphorus since P is 44% of P_2O_5 by weight. Finally, we used the spreadsheet default for BOD, which assumes that BOD is twice the soil nitrogen concentration.

[9] Personal communication from Nathan Hill, Winnebago County Soil and Water Conservation District, December 20, 2007

Table A-8

	Areas of HSG classes by subwatershed							
Sheds	A/D	B	B/D	C	D	No data	Total	Avg
180	242	2,274	251	384	48	118	3,317	B
189	44	5,452	341	768	5	57	6,667	B
203	458	2,020	28	291	0	21	2,818	B
210	197	353	7	151	0	3	710	B
213	31	485	19	1,364	34	12	1,944	C
216	14	537	137	2	0	1	691	B
224	1	522	151	203	1	3	881	B
225	317	1,671	85	521	70	33	2,698	B
229	3	723	52	14	27	3	823	B
246	49	614	60	958	22	8	1,710	C
254	72	352	100	1,035	32	22	1,613	C
260	595	1,172	159	660	3	11	2,600	B
264	0	519	67	34	0	1	621	B
273	396	1,069	145	1,191	71	120	2,991	C
282	207	543	128	642	11	17	1,548	C

INPUT TABLE 6: REFERENCE RUNOFF CURVE NUMBER

We originally attempted to account for the effects of imperviousness on watershed hydrology through the curve number method, but returned to the default curve number values for each land use because of poor agreement with the Illinois State Water Survey's streamflow model. STEPL uses the Natural Resources Conservation Service curve number method to estimate runoff. The basic equation is:

$$Q = \frac{\left(P - 0.2(\frac{1000}{CN} - 10)\right)^2}{P + 0.8(\frac{1000}{CN} - 10)} ,$$

where Q is runoff, P is rainfall, and CN is the curve number, a quantity that reflects soil and cover conditions and that can be related to land use.[10] STEPL computes average annual runoff using this equation and long-term rainfall data from the weather station provided at the top of the *Input* sheet. The default CN values for the general land cover categories, shown in Table A-9, from the Natural Resource Conservation Service's Technical Release 55 (TR-55) were considered appropriate for the baseline analysis. Wetlands and water are assumed to have the default CN values for the user defined category.

Table A-9

		Curve number by SHG			
General land cover	**NRCS cover description**	**A**	**B**	**C**	**D**
Urban	From urban subclass	From urban subclass			
Cropland	Straight row, good condition (factors tend to improve infiltration and decrease runoff)	67	78	85	89
Pastureland	Continuous forage for grazing, fair condition (50-75% ground cover and not heavily grazed)	49	69	79	84
Forest	Fair condition (woods grazed but not burned, some forest litter covers soil)	39	60	73	79
Wetland/water/NEC	Not in TR-55	50	70	80	85

[10] Natural Resources Conservation Service. 1986. *Urban Hydrology for Small Watersheds*. Technical Release 55. Retrieved from: http://www.ecn.purdue.edu/runoff/lthianew/documnt/doc_dwnld/tr55.pdf

The default CN values for the urban subclasses in STEPL Table 6a are also from the Natural Resource Conservation Service's Technical Release 55 (TR-55). However, they tend to assume much higher impervious coverage than is actually found in the watershed, as estimated from tabulating impervious coverage in the 2001 National Land Cover Dataset by the categories in the 2001 NIPC land use inventory. This gives the impervious cover percentages in the column "IC" in Table A-10.[11] Using the general methodology outlined in TR-55 (Ch. 2) and values from Purdue University's L-THIA program,[12] watershed-specific curve numbers were developed using these impervious cover values to replace the default values. For soil hydrologic groups B and C (the main types in the watershed), the curve number was calculated as:

SHG B: $CN = 0.29 \times IC + 69.024$,
SHG C: $CN = 0.19 \times IC + 79.024$,

where IC is percent impervious cover. These equations assume that all pervious surface in urban areas is grass in "fair" condition (itself modeled as pasture in "fair" condition), and that impervious areas have a CN of 98 and are directly connected to the drainage system.

Table A-10

	Default CN					Imperviousness-based CN			
Urban subclass	A	B	C	D	**IC**	A	B	C	D
Commercial	89	92	94	95	56%	76	85	90	92
Industrial	81	88	91	93	33%	65	79	85	89
Institutional	81	88	91	93	24%	61	76	84	87
Transportation*	98	98	98	98	27%	62	77	84	88
Multi-Family	77	85	90	92	37%	67	80	86	89
Single-Family	57	72	81	86	23%	60	76	83	87
Urban-Cultivated	67	78	85	89	—	67	78	85	89
Vacant-Developed	77	85	90	92	—	77	85	90	92
Open Space	49	69	79	84	7%	52	71	80	85

* The transportation category is actually transportation, communication, and utilities (TCU), so it can include land uses with low imperviousness, such as utility rights of way.

Because the "urban – cultivated" and "vacant – developed" categories are not found in a representative form in the CMAP land use inventory, current impervious cover could not be computed and so the default curve number was used.

[11] The NIPC land use inventory does not include a category similar to "urban – cultivated," but the CN values are assumed to be the same as in cropland. The "vacant – developed" category is a very small part of the watershed and is partly composed of land under construction, so imperviousness estimates would probably be unrepresentative. The default values are used.

[12] See http://www.ecn.purdue.edu/runoff/lthianew/imperv/calccusCN.htm for tabular data. These values were plotted in Excel and a linear equation was fit to them ($r^2 = 1$). See http://www.ecn.purdue.edu/runoff/lthianew/toolim.htm for a broader overview of the method.

INPUT TABLE 7: NUTRIENT CONCENTRATION IN RUNOFF (MG/L)

STEPL Table 7 addresses nutrient concentration in runoff from non-urban land, but except for croplands, runoff from non-urban lands is dealt with in STEPL essentially like it is from urban sources: by assuming a static mean concentration. For cropland, by contrast, nutrient concentrations in runoff are assumed to relate to the number of animals present in the watershed. For watersheds such as the Upper Kishwaukee with animal densities of less than 1,500 pounds per acre, the nitrogen concentration default is 1.9 mg/L. Were the cropland manured, the default is 8.1 mg/L for the months of the year that manure is applied. This method ignores the influence of fertilizer application, yet no method readily integrated with STEPL was available to estimate its contribution. We therefore turned to a study performed by the Northeastern Illinois Planning Commission as part of the Clean Water Act Section 208 program which measured event mean concentrations at four sites of "general agriculture" in the region.[13] The nutrient EMCs used are shown in Table A-11.

Table A-11

Land use	Nitrogen (mg/L)	Phosphorus (mg/L)
Cropland	7.1	0.53
Pastureland	3	0.25
Forest	0.2	0.1
Water/wetlands	0	0

INPUT TABLE 8: INPUT OR MODIFY URBAN LAND USE DISTRIBUTION

The 2005 NIPC land use inventory was used to subclassify urban land cover as described in the discussion for Input Table 1. Table A-12 below shows the subclassification of the urban land cover category by acreage for each subwatershed.

Table A-12

Subsheds	Commercial	Industrial	Institutional	Trans-portation	Multifamily	Single family	Urban - cultivated	Vacant - Developed	Open Space	Total Urban
180	6	87	58			972	136	6	273	1,537
189	1	76				514	210	8	11	820
203	72	223	98	1	1	255	162	119	336	1,268
210	69	43	1	12	21	117	2	2	126	393
213	6					154	67		3	230
216						12	21			33
224				20		52	22	2	0	96
225	22	34	20			411	123	18	29	657
229			4			65	29			99
246	1		1			108	89	26	128	354
254	12		11			181	32	23	40	298
260	6					263	51	0	16	336
264						162	68		1	230
273	8	91	18	28	11	894	88	64	299	1,500
282		0		0		355	48	19	92	515
Total	204	554	211	60	33	4,514	1,152	286	1,353	8,367

[13] G. Roy Elmore. 1977. Water Quality Sampling and Analysis in the 208 Program. Staff Paper No. 14. Northeastern Illinois Planning Commission.

URBAN TABLE 1: URBAN POLLUTANT CONCENTRATION IN RUNOFF (MG/L)

STEPL computes the pollutant load contribution of urban areas by using a typical *event mean concentration* — the total pollutant load divided by the total runoff produced by a given storm — in runoff from each urban land use. Many studies[14] have measured event mean concentrations and CMAP has historically used values developed in a metaanalysis by the Northeastern Illinois Planning Commission.[15] The Illinois Environmental Protection Agency also uses these values in the load reduction spreadsheets it requires to be completed as part of a Section 319 program application. For these reasons the default values were replaced with the mean concentrations drawn from the Price/NIPC study, with the exception of the values for "urban – cultivated" and "vacant (developed)." These categories are not found in a perfectly matching form in the Price/NIPC study (Table A-13), so the STEPL default values were used.

Table A-13

STEPL	**Pollutant Concentration in Runoff (mg/L)**								
Land Use	Commercial	Industrial	Institutional	Trans-portation	Multi-Family	Single-Family	Urban-Cultivated	Vacant (developed)	Open Space
Total Nitrogen	2	2.5	1.8	3	2.2	2.2	1.9	1.5	1.5
Total Phosphorus	0.2	0.4	0.3	0.5	0.4	0.4	0.3	0.15	0.15
Biological Oxygen Demand	9.3	9	7.8	9.3	10	10	4	4	4
Total Suspended Solids	75	120	67	150	100	100	150	70	70
NIPC/ Price model									
Land Use	Commercial	Industrial	Institutional	Trans-portation	Multi-family	Residential			Open Space
Total Nitrogen	3.6	2.6	3.2	2.3	3.2	3.1	—	—	0.7
Total Phosphorus	0.23	0.27	0.42	0.32	0.42	0.4	—	—	0.39
Biological Oxygen Demand	15	9	16	9	16	11	—	—	1
Total Suspended Solids	206	230	391	395	391	153	—	—	60

POLLUTANT LOADING FROM WETLANDS/WATER CATEGORY

It is assumed that the wetlands/water/NEC land cover category does not contribute pollutants in the sense that wetlands and bodies of water would not produce nutrient-enriched or sediment-laden runoff. This assumption was inserted into STEPL by changing the table labeled "Sediment and sediment nutrients by land uses with BMP (ton/year)" on the *Sediment* sheet to show zero values for the user defined (wetlands/water/NEC) land cover classification.

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[14] U.S. EPA has supported development of a number of applications that use the so-called simple method and event mean concentrations to estimate pollutant loading. As part of the PLOAD model that is a component of BASINS, a U.S. EPA contractor prepared a compilation of event mean concentrations that can be compared with the Price/NIPC study. It is available at http://www.epa.gov/waterscience/BASINS/b3docs/PLOAD_v3.pdf, Appendix IV. Different regions can be expected to have different typical concentrations of pollutants in urban runoff.

[15] Tom Price. 1993. *Unit Area Pollutant Load Estimates for Lake County, Illinois Lake Michigan Watersheds*. Report prepared by Northeastern Illinois Planning Commission for Lake County Stormwater Management Commission.

METHOD FOR INCORPORATING THE EFFECTS OF EXISTING BMPS

The gross load computed by STEPL considers only the pollutant mass washed off the landscape annually; thus, STEPL overestimates actual loading to the stream if the effects of BMPs currently in place in the watershed are not incorporated. These existing BMPs were assigned by land cover. For cropland, the only BMP analyzed was the filter strip. The watershed coordinator for the Kishwaukee River Ecosystem Partnership had identified cropland within 100 feet of streams, which is equivalent to cropped areas lacking adequate grassy or forested buffer. CMAP staff used the KREP shapefile to "erase" the area within the 100 foot buffer that had inadequate buffers, although in practice a 90 foot buffer on either side of the stream centerline was used to avoid creating slivers as the KREP shapefile went from the streambank. The resulting well-buffered area then was taken to represent existing places with the equivalent of a filter strip already in place in the watershed. To determine how much of each subwatershed was treated by these filter strips, it was assumed that the average width of a buffer would be 50 feet so that the length of a filter strip = area of existing buffer ÷ 50. Then the area served was assumed to be 300 feet on one side of the buffer, or the approximate limit of sheet flow.[16]

Table A-14

Subwatershed	Subwatershed area	Existing buffer area (ac)	Buffer length (ft)	Area treated (ac)	% watershed treated
180	3334	7	6505	45	1.3
189	6667	43	37728	260	3.9
203	2921	15	13077	90	3.1
210	737	3	2666	18	2.5
213	1972	40	34893	240	12.2
216	691	14	11888	82	11.9
224	881	20	17027	117	13.3
225	2707	23	19778	136	5.0
229	823	6	5511	38	4.6
246	1698	14	12185	84	4.9
254	1634	13	11269	78	4.7
260	2600	2	1535	11	0.4
264	621	13	11077	76	12.3
273	2863	7	5878	40	1.4
282	1546	24	20517	141	9.1
Total		243		1457	

For urban land cover, the urban BMP tool in the *BMPs* sheet was used. Aerial photography (2005 vintage) for each subwatershed within 2005 municipal boundaries was examined for the presence of dry or wet ponds, which are the only BMPs reliably identifiable from aerial photographs. Urban land uses in unincorporated areas were assumed to have no BMPs. The land use and approximate tributary area for each type of BMP was then determined and entered into STEPL. Table A-15 shows the results.

[16] Natural Resources Conservation Service, op. cit., p. 3-3.

Table A-15

Subwatershed	Commercial	Industrial	Institutional	Transportation	Multi-Family	Single-Family	Urban-Cultivated	Vacant (developed)	Open Space
180						326 WP			
189									
203	72 DD	226 DD				60 DD			
210		9 DD			21 WP				
213									
216									
224									
225									
229									
246									
254									
260									
264									
273					2 WP	315 WP			
282									

DD = dry detention, WP = wet pond, numbers are acres served by each BMP